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The Navy's marine mammal program has explored a variety of designs for portable self-contained marine mammal pools to support maintaining animals during system deployments. As a consequence, a simplified concept for an easily transported pool and filtration system has been developed. NRAD's efforts in designing, operating, and testing these pools have to date proven their suitability for maintaining bottlenose dolphins without incident for periods of over two weeks. The design could also be modified for holding pinnipeds with little effort. Material costs of this pool design average \$5000, most components are available off-the-shelf, and set-up can be easily accomplished in a single day, even in remote areas. Operating procedures for proper maintenance of water quality and animal handling are also discussed in this poster. This type of design may benefit other marine mammal facilities with a requirement for portable temporary holding pools, especially for medical isolation or stranding rehabilitation use.

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AN INEXPENSIVE PORTABLE POOL SYSTEM USEFUL FOR TEMPORARY HOUSING, MEDICAL ISOLATION, AND STRANDING REHABILITATION OF MARINE MAMMALS

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Abstract: The Navy's marine mammal program has explored a variety of designs for portable self-contained marine mammal pools to support maintaining animals during system deployments. As a consequence, a simplified concept for an easily transported pool and filtration system has been developed. NRaD's efforts in designing, operating, and testing these pools have to date proven their suitability for maintaining bottlenose dolphins without incident for periods of over two weeks. The design could also be modified for holding pinnipeds with little effort. Material costs of this pool design average \$5000, most components are available off-the-shelf, and set-up can be easily accomplished in a single day, even in remote areas. Operating procedures for proper maintenance of water quality and animal handling are also discussed in this poster. This type of design may benefit other marine mammal facilities with a requirement for portable temporary holding pools, especially for medical isolation or stranding rehabilitation use.

Background: The Navy has developed a system to temporarily house trained dolphins in inflatable pools placed on ships at sea which are engineered to withstand the pitch and roll one may experience on the ocean. As part of the behavioral conditioning process for adapting to these containers, the navy dolphins are first introduced to non-inflatable vinyl pools set up on land. This allows our trainers to adapt the dolphins gradually to a smaller environment than their normal open-bay enclosures. We have maintained dolphins in these pools for periods of over two weeks without incident, and have researched the water quality parameters to better understand the requirements for a healthy marine mammal pool. The portable vinyl pools we use are available from local distributors at low cost. Both open-circuit and closed-circuit seawater systems have been developed for our pools, along with protective sunscreens.

Pool design: Our requirements called for a lightweight pool capable of being easily transported and assembled. An evaluation of commercial products led us to the K-D pool, which seemed the most suitable. The K-D pool is manufactured from a triple layer material (polytriply) consisting of a PVC coated polyester membrane advertised as being tear and rip proof. Patch kits are included should a hole develop. The support ribs and legs of the pool are made of hardened PVC and aluminum rods and unions that quickly snap together and

slide through pockets in the pool liner. Assembly can be accomplished in less than two hours by two people with very few tools required (screwdriver recommended). We placed foam pads beneath the pools before filling in order to protect the animals from abrasion on a hard bottom surface. The shadetops were fabricated in-house from aluminum pipe, net panels, and shade cloth material for sun cover and to prevent animals from accidentally sliding out of the pools. Initially, a 16 foot pool (6,000 gals.) was tested for housing one dolphin temporarily with good results. The 20 foot models (9,400 gals.) were later tested for holding pairs of dolphins, again with good results.

Filter system: Considerations for a self-contained filter system involved a design that 1) could be fitted on a pallet and be light enough to easily move around, and 2) be easy to operate and maintain. We selected a pump with sufficient water flow to produce a one-hour turnover (100-125 GPM), which consequently dictated surface area requirements for the filter. Table 1 describes options for available commercial designs for a small pool to achieve this flow. We decided on a cartridge filter system primarily for its portability and high filtration capacity, although this filter may not prove acceptable for use with some marine mammals (e.g. pinnipeds). The plumbing consists of 2" PVC flex pipe and three 2" ball valves used in this design. Skimmer and return flows are directed through the pool fittings, while a drain tube runs over the pool side and connects to a perforated PVC pipe strapped to the pool bottom.

TABLE 1: Filter Considerations

FILTERS	HIGH-RATE SAND	CARTRIDGE	D.E.
Flow rate gpm per sq. ft.	10-20 gpm recommended	.28 gpm maximum	1.5 gpm recommended
Filtration area	10-15 sq.ft. recommended	450 sq.ft. standard	53 sq.ft. standard
Working pressure	10-20 psi 50 psi max	10-15 psi 50 psi max	8-15 psi 50 psi max
Relative weight	Heavy least portable	Light most-portable	Light semi-portable
Additional requirements	backwash water supply and extra plumbing	2 extra filter elements	extra valves, extra DE, and backwash water
Anticipated filter runs	4 to 6 days	5 to 7 days	2 to 3 days
Maintenance time per filter run	5 to 10 mins. to backwash	60 mins. to change & wash 2 elements	20 mins. to backwash and recoat DE

Water quality: Maintenance of water quality for marine mammals in closed circuit pools can be challenging. In order to simplify the operating procedures and chemical requirements, we selected two automated systems for initial testing: a Tarn-Pure copper-silver flow cell, manufactured by LiquiTech, Inc., and an off-line chlorine feeder manufactured by Hayward Pool Products, Inc, utilizing slow dissolving trichlor tablets. The Tarn-Pure flow cell delivers copper and silver ions to the water for combating pathogenic micro-organisms and algae growth. Low level chlorination was selected for an oxidizing agent to control buildup of ammonia and nitrogenous waste products contained in the animal's feces and urine. To date, we have successfully maintained one animal with this design for up to 10 days without the need to replace water. Longer periods would require some water exchange to occur due to build up of nitrogenous compounds, cyanuric acid and increased total dissolved solids (TDS). Coliform levels consistently stayed near zero owing to the effectiveness of the Tarn-Pure system. Table 2 is a representation of the water quality parameters we maintained. Alternate sanitizing and oxidizing agents, such as bromine and potassium monopersulfate, are presently being researched. We also operate several pools as flow-through systems and have maintained animals for longer periods due to the availability of raw sea water at our facility (filters and chemical feeders are not used in those designs).

Table 2: Water Quality Parameters

Parameter	Desired Range	Measured Levels
Total Chlorine	0.5 to 1.0 ppm	1.5 ppm max
- Free Cl	0.05 to 0.8 ppm	0.5 ppm max
- Combined Cl	0.2 to 0.5	1.0 ppm max
Copper	.25 to .35 ppm	.45 ppm max
Silver	Below 0.02 ppm	undetectable
Ammonia	0.0 to 2.0 ppm	3.0 ppm max
Coliform	Below 1000/100cc	3/100cc max
pH	7.2 to 8.2	7.4 to 8.0
Temperature	65 to 78 F	68 to 74 F
Salinity	Ambient (35-40 ppt)	40 ppt max

Conclusions: Our tests on this design have shown that bottlenose dolphins can be easily maintained in such pools on a closed system for short periods, and for longer periods given periodic water replacement. With minor modifications, a suitable design could also be developed for other marine mammals (pinnipeds, otters, etc). This design's portability, low cost, commercial availability, ruggedness, and potential ease of operation make it suitable for several field applications. Such a design appears especially useful for medical isolation and treatment of stranded marine mammals, and is within the reach of most rescue and rehabilitation programs. We are happy to share more information on our research with interested parties.

References: Our protocol for testing this design was based on information provided in the following reference documents:

Sterilization of marine mammal pool waters: Theoretical and health considerations.
Spotte, S. (1991) APHIS Technical Bulletin No. 1797.

Handbook of chlorination, White, G.W. (1972) Van Nostrand Reinhold Co., New York.

Tarn-Pure operators manual and supporting documentation, Tarn-Pure USA, 3854 Schiff Dr., Las Vegas, NV, 89103.

Caribbean Clear owners manual for model 50-R system, Caribbean Clear Systems, 151-B Riverchase Way, Lexington, SC, 29072.

U.S. Federal Register, January 14, 1991, p. 1471 and January 30, 1991, p. 3597: Definitions for regulation of silver ion concentration in human drinking water and for Secondary Maximum Contaminant Levels, respectively.

NRaD Memo Ser 514/69-92: **Shipboard Tank Utilization.** Animal Care and Utilization Committee, NRaD Code 514.

NRaD Memo 6/6/94: **Proposal for testing and evaluation of Tarn-Pure based closed system SFD pool using chemical oxidizers.** Animal Care and Utilization Committee, NRaD Code 514.

Source guide:

K-D Pools: K-D Products, Inc., 1120 Calle Cordillera,
San Clemente CA 92673 (800) 777-3553

System 3 Filters and Sta-Rite Pumps:

Sta-Rite Pool/Spa Group, 600 S. Jefferson St.,
Waterford, WI 53185 (800) 752-0183

Off-Line Chlorinator:

Hayward Pool Products, Inc., 900 Fairmount Ave.,
Elizabeth, NJ 07207

Tarn-Pure Copper-Silver Flow Cell:

LiquiTech Inc, 241 South Frontage Road, Suite 40,
Burr Ridge, IL 60521 (800) 635-7873

Water Testing Kits:

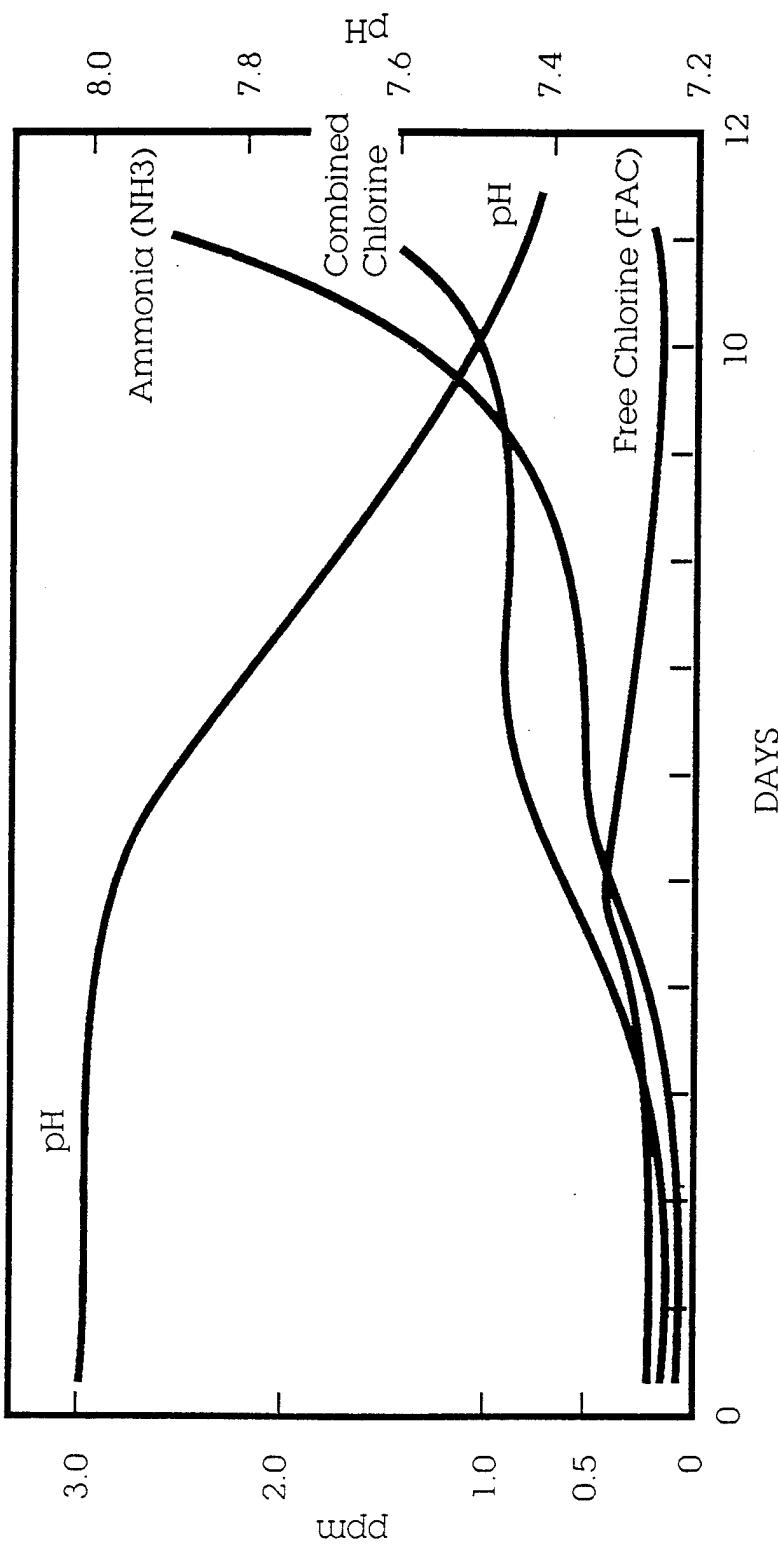
LaMotte Company, PO Box 329, Chestertown MD 21620
(800) 344-3100

Taylor Kits, available at most pool distributors.

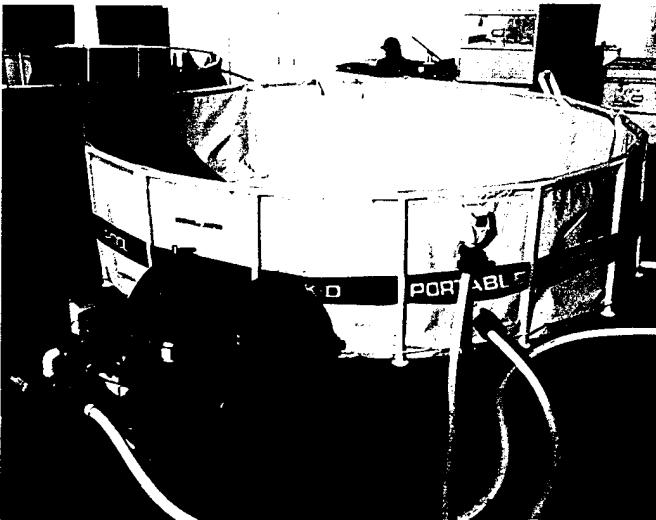
Dry-Tab aquarium tests, found at most pet stores.

Plumbing items (valves, pipes, flex hose) and pool chemicals (Trichloro-S-Triazinetrione tablets, soda ash, muriatic acid) are available at most pool distributors or hardware suppliers. Aluminum piping, shade cloth, net panels, and foam pads can be found at many hardware and garden supply stores.

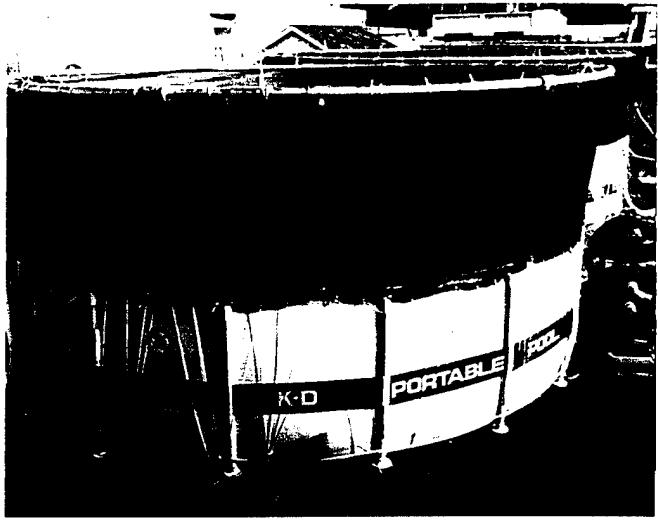
Water Quality Changes in a Closed System Portable Pool



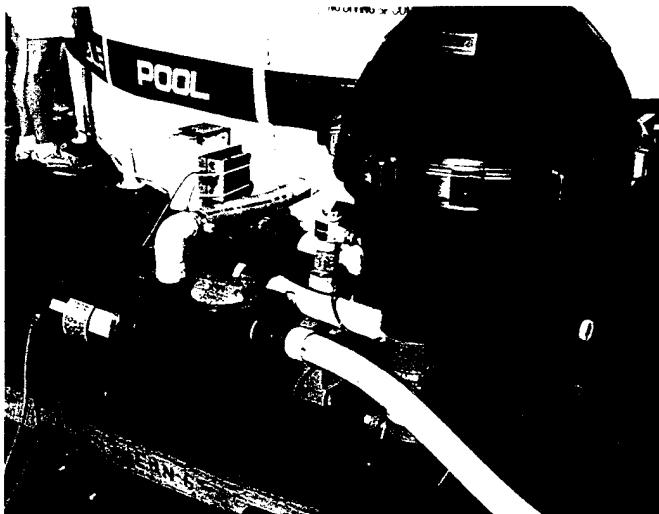
Water quality parameters over a twelve day period with a single dolphin being housed in the pool. The animal was moved from the pool after ten days, when the water quality began to decline.



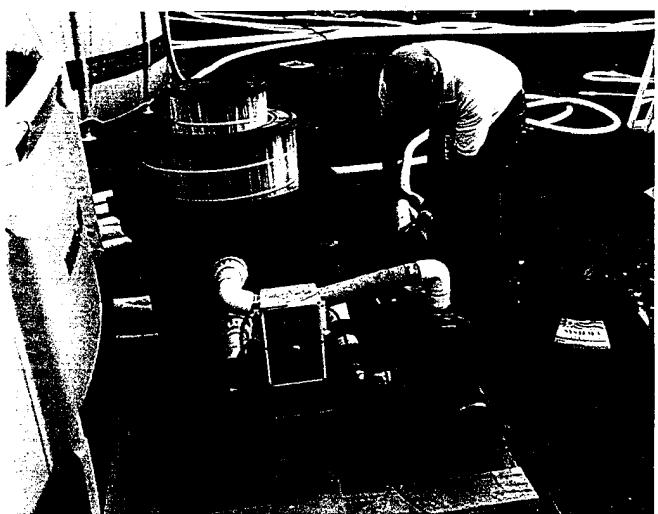
The portable pool system shown before filling.



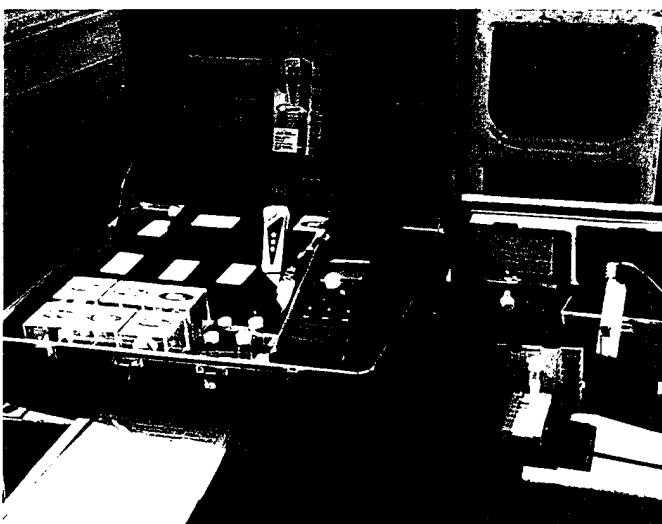
The portable pool system shown after filling and with the shade top installed.



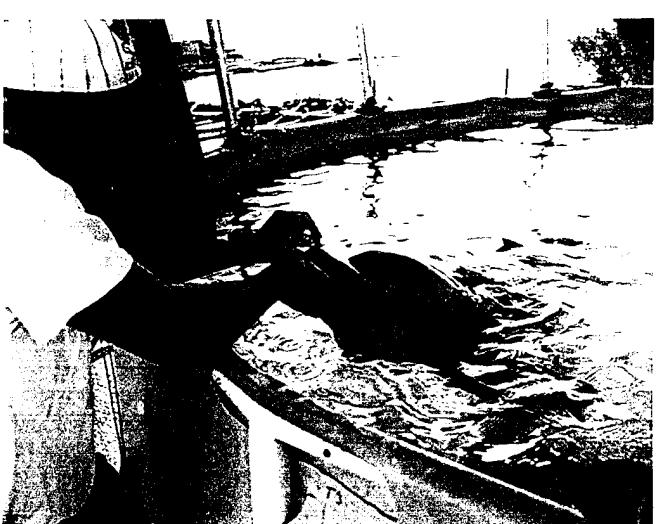
The portable filter system is contained on a single pallet and is easy to move about.



Flexible PVC pipe is used in our design. Note the dual element cartridge filter and the Tarn-Pure flow cell (foreground).



The field kit used for monitoring water quality included a colorimeter, a variety of individual reagent sets and some standard pool test kits.



Water quality after 5 days with a single dolphin remained excellent.